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Effect of bacteria on strength, permeation characteristics and micro-structure of silica fume concrete

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HIGHLIGHTS

- Effect of bacteria on strength and permeation properties of concrete is presented.
- Concrete is made with 0, 5, 10, and 15% silica fume as cement replacement.
- Economic study of bacterial SF concrete is also covered.

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ABSTRACT

Influence of bacteria on strength and permeation characteristics concrete incorporating silica fume (SF) as a substitution of cement has been investigated in this study. The cement was partially substituted with 5, 10 and 15% SF and with constant concentration of bacterial culture, 10^5 cfu/mL of water. Cement was substituted with silica fume in concrete by weight. At 28 d, nearly 10–12% increase in compressive strength was observed on incorporation of bacteria in SF concrete. At 28 d, the compressive strength of concrete increased from 32.9 to 36.5 MPa for SF, 34.8 to 38.4 MPa for SF5, 38.7 to 43.0 MPa for SF10 and 36.6 to 40.2 MPa for SF15 on addition of bacteria. Water absorption, porosity and capillary water rise reduced in the range of 42–48%, 52–56% and 54–78%, respectively, in bacterial concrete compared to corresponding nonbacterial samples at 28 days. Reduction in chloride permeability of bacterial concrete was observed and the total charge passed through bacterial concrete samples reduced by nearly 10% compared to nonbacterial concrete samples at 56 d of age. At 28 d, total charge passed through concrete reduced from 2525 to 1993 C for SF, 1537 to 1338 C for SF5, 961 to 912 C for SF10 and 1186 to 1174 C for SF15 on addition of bacteria. Calcite precipitation on addition bacteria and confirmed by SEM and XRD analysis is considered as the reason for improvement in properties of concrete. Economic study of bacterial SF concrete has also been carried out in the present work. The Benefit/Cost Ratio of bacterial SF concrete got reduced with the increase in SF quantity. Compared to control concrete, bacterial SF concrete containing 10% silica fume demonstrated highest benefit in improvement in its properties and corresponding highest Benefit/Cost Ratio.

1. Introduction

Supplementary cementing materials (SCMs) are extensively used in enhancing concrete properties. Waste/by-product materials used as SCM in concrete constructions not only check the environmental contamination but also enhance the concrete properties in fresh as well as in hardened state. Silica fume (SF) is generated by silicon metal or ferrosilicon alloys producing industry and has

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